Hydromorphological and ecological impacts of water injection dredging in the River Parrett, Somerset Levels, Somerset, UK

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Introduction

The Somerset Levels (‘The Levels’ hereafter) are a low-lying and flood-prone agricultural landscape in South West England. The rivers and ditches of The Levels are heavily managed for navigation and flood relief purposes and there is a legacy of dredging, typically using mechanical dredging apparatus, to help mitigate flood risk. Despite the widespread application of the technique internationally, knowledge of the short to medium-term effects of dredging on the wider ecosystem remains limited. In addition, the potential effects of new dredging technologies, such as water injection dredging, on instream biota have rarely been considered or quantified. As a result, a programme of field experiments investigated the ecological (macroinvertebrate, diatom, fish) and hydromorphological (bed material grain size, bathymetry, water physicochemistry) effects of water injection dredging temporarily and spatially within the River Parrett, Somerset (Figure 1).

Methods

Ecological and hydromorphological sampling occurred at an upstream site (control), within the managed area (treatment) and downstream of the 4.7 km dredge reach (downstream; Figure 2), before, during and after dredging activities. Specifically:

1) Reach-scale bathymetric data were collected before and after dredging (Figure 2a).
2) Water physicochemistry (pH, turbidity, conductivity, salinity and dissolved oxygen) was monitored at a single site located downstream of the dredge reach (Figure 2a).
3) Fish populations were surveyed via seine netting at control, treatment and downstream sites on three occasions before dredging, immediately after dredging and approximately 3 and 5 months after dredging (Figure 2b). Additionally, during dredging, the sediment plume was surveyed via pelagic trawling at a single site (Figure 2b) and the captured fish were inspected for mortality or dredging-induced symptoms.
4) Ekman grab samples (n = 3) were collected from 6 sites (1 control, 3 treatment, 2 downstream) on two occasions pre-dredging and on three occasions post-dredging (immediately, 3 months and 5 months after management), and used to assess benthic diatom and invertebrate populations. In addition, marginal sweep samples were collected at each of the sites and at each of the sampling points for macroinvertebrates. We present and discuss a selection of results here, with a focus on pre- vs immediately post-dredging comparisons for some of the treatment sites.

Results

1. DEMs of difference indicate that, on average, 93% of the dredge reach bed area had been eroded following management (Fig. 3). Dredging was associated with a net loss of 33,915 m² of sediment.

2. Turbidity peaks were relatively unaffected by dredging (comparable in magnitude to pre-dredge high tide peaks; Figure 4). However, base turbidity was elevated during the dredging vs. pre-dredging period (before = 91 NTU; during = 635 NTU; 697% increase), and did not revert back to pre-dredging levels.
3. A total of 118 fish were captured during dredging. All fish were alive and showed no obvious signs of dredging-induced stress or illness.

Conclusion

Initial experiments as part of a larger programme of work demonstrate that dredging had a significant effect on channel bathymetry and that dredging activities impacted ambient turbidity, but not turbidity peaks. Changes in the physical environment corresponded with adjustments in ecological communities, where reductions in fish and marginal invertebrate populations were detected at a single site within the dredge reach. Further analysis is required to better understand the causes of community changes temporally and spatially, to assess whether these were in response to management or other natural biotic/ abiotic factors. Studies such as these are integral for understanding the factors that contribute to successful flood risk management and restoration and form a fundamental bridge between academic research to underpin practice.